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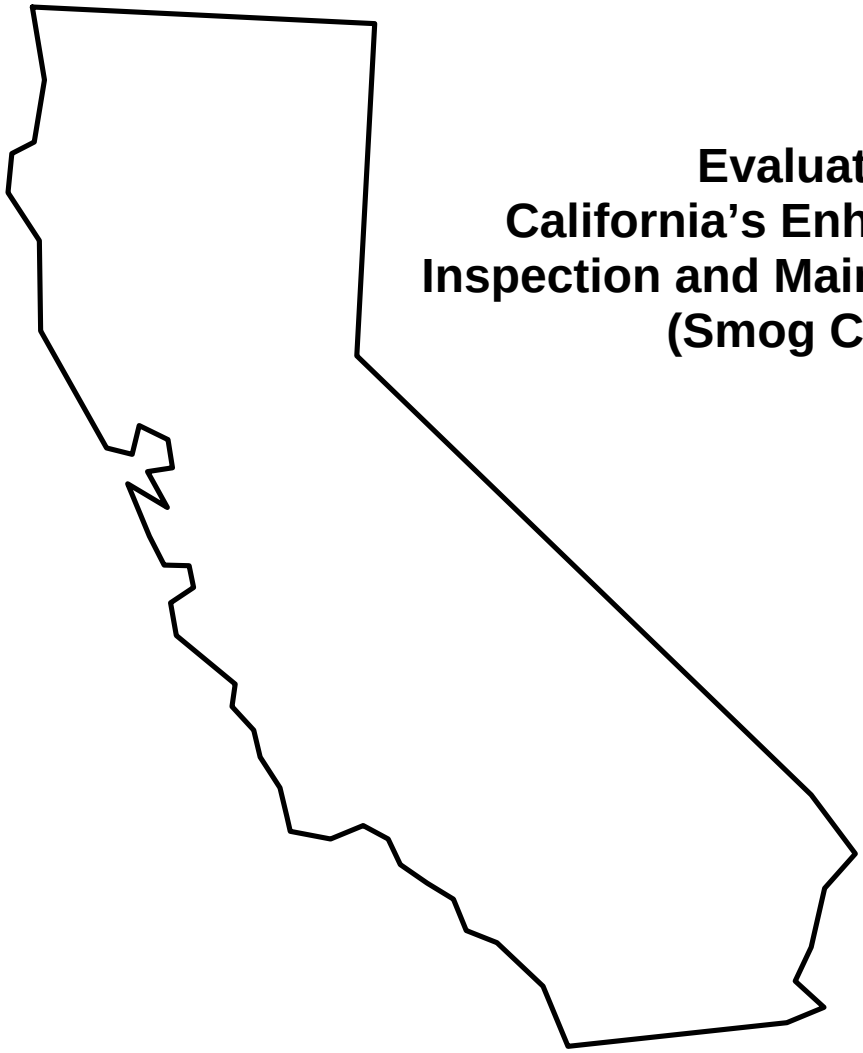

Evaluation of California's Enhanced Vehicle Inspection and Maintenance Program (Smog Check II)

Release Date: April 27, 2000

California Environmental Protection Agency

Air Resources Board

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EXECUTIVE SUMMARY

Major Findings

The Enhanced Inspection and Maintenance (I/M) program, known as Smog Check II in California, is achieving significant emission reductions needed to meet health-based air quality standards. In this report, we quantify the effectiveness of the Enhanced I/M program for the primary evaluation period from November 1998 through October 1999, for comparison to the legal targets established by 1994 California State Implementation Plan (SIP) for Ozone. We also examine the additional nitrogen oxide (NOx) benefits that result from today's tighter inspection standards, which were not in place during the evaluation period. We also predict these additional benefits in future years.

Program Effectiveness in Summer 1999. Using roadside test data from over 9,000 vehicles, we estimate that the Enhanced I/M program achieved combined emission reductions of 45 tons per day (TPD) of hydrocarbons (HC) plus NOx in Summer 1999, compared to the SIP target of 112 TPD. The program achieved an overall 40 percent of the expected emission reductions for 1999. The SIP target is the total emission reductions anticipated in 1999 for each of the six regions in the State required to implement Enhanced I/M.

Although the Enhanced I/M program is producing substantial benefits, the reductions achieved fall short of the SIP target for thee primary reasons: (1) legislative changes weakened the Enhanced I/M program; (2) the more rigorous program elements are being phased in over a longer timeframe; and (3) the 1994 SIP target assumed additional communities outside urbanized areas and heavy-duty gasoline trucks would be subject to Enhanced I/M.

Program Effectiveness Today. The current program in place today is *more effective* than the program in place in Summer 1999*,* achieving 67 TPD of HC plus NOx, or an overall 60 percent of the expected emission reductions compared to the same SIP target. This increase is due to the more rigorous NOx inspection criteria implemented in October 1999 (at the end of the program evaluation period).

Given that the program is not using the even more stringent final inspection standards assumed in the 1994 SIP to pass and fail vehicles, these results are encouraging. Nevertheless, the program is not accomplishing all of the expected reductions; changes to increase program effectiveness are needed.

Using the Air Resources Board's (ARB's) draft motor vehicle emission model to predict the future benefit of potential modifications, effective changes appear available. These changes include implementing more stringent inspection standards (known as "cut points"), limiting the older vehicle exemption to vehicles that are already exempted, and developing more comprehensive checks for evaporative system and liquid leaks. Moving to interim cut points that are approximately halfway between current cut points and the originally envisioned "final" cut points would increase the effectiveness of the program in meeting the SIP commitment by about five percentage points for HC and by almost 15 percentage points for NOx. Limiting the older vehicle exemption to already exempted vehicles (pre-1974 model years) would also increase the effectiveness of the program.

Background

California has two types of inspection programs. Enhanced I/M, which is applicable to vehicles in the State's smoggiest regions, is a more rigorous version of the Basic I/M program administered by the Bureau of Automotive Repair (BAR) to ensure vehicles stay clean as they age. In this report, we use the terms Enhanced I/M and Smog Check II interchangeably. The Smog Check programs are important strategies to improve air quality and protect public health by reducing emissions. Smog Check helps assure that vehicles continue to comply with applicable emissions standards through proper maintenance and repair of emission control systems.

Enhanced I/M is required by the federal Clean Air Act for regions with serious ozone or carbon monoxide (CO) pollution problems. Enhanced I/M has been implemented in the urbanized portions of Los Angeles, Ventura, San Diego, the Sacramento metropolitan area, the Southeast Desert (Coachella and Antelope), and the San Joaquin Valley. Since ozone is formed in the atmosphere, the testing program measures the pollutants that cause ozone: HC and NOx. (Hydrocarbon emissions from vehicles have two sources – exhaust from the tailpipe and evaporative emissions from faulty gas caps and fuel system leaks.) HC and NOx also react with other chemicals in the atmosphere to form inhalable particulate matter. Both of these pollutants cause or exacerbate lung disease.

The distinguishing features of the Enhanced I/M program include testing on a treadmill-like device that allows measurement of NOx emissions, and inspection of vehicles most likely to have high emissions at specialized, Test-Only stations. Basic I/M is in place in much of the remainder of the State. The Basic program does not measure NOx emissions, and all testing can be performed at the same station that performs repairs. Table ES-1 compares the Enhanced and Basic I/M programs in more detail. The key additional elements of the Enhanced program are shown in bold.

Our clean air plan is predicated on an effective Enhanced I/M program. Enhanced I/M is a key element of California's clean air plan -- the ozone SIP -- which was adopted by local air districts and the ARB in 1994. U.S. EPA approved the SIP in 1997, making the emission reduction commitments federally enforceable. In the SIP, Enhanced I/M is expected to provide one-quarter of all the new near-term emission reductions needed to meet or make progress toward clean air standards.

Table ES-1
Comparison of Current Smog Check Programs

	BASIC I/M	ENHANCED I/M
Test Frequency	Biennial	Biennial
Test Type	Visual and functional test; BAR-90 test (two-speed idle (TSI))	Visual and functional test; **BAR-97 test (loaded-mode; Acceleration Simulation Mode (ASM))**
Vehicles Tested*	PC, LDT, MDV, HDT *(excluding diesel & electric vehicles)*	**PC, LDT, MDV tested with BAR-97;** All-wheel drives & HDT tested with BAR-90 *(excluding diesel & electric vehicles)*
Evaporative Test	Gas cap pressure test	Gas cap pressure test
Pollutants Measured	HC, CO	HC, CO, **NOx**
Model Years Tested	4 year old & newer vehicles exempt; 1973 vehicles & older exempt until 2003 when anything older than 30 years will be exempt	4 year old & newer vehicles exempt; 1973 vehicles & older exempt until 2003 when anything older than 30 years will be exempt
Repair Cost Waiver and Hardship Extension	One-time $450 (or $250 through economic hardship extension); Gross polluters are eligible for waiver	One-time $450 (or $250 through economic hardship extension); Gross polluters are eligible for waiver
Station Types	Test and Repair	Test and Repair; **Over 15% of vehicles directed to Test-Only**
Test Result Transmission	Electronic	Electronic
Cut Points	Two-speed idle	**Initial cut points used in 1998-1999; More stringent cut points instituted in October 1999**

*PC = passenger car; LDT = light-duty truck; MDV = medium-duty vehicle; HDT = heavy-duty truck

About this report. We have developed this report to meet the requirements of state and federal law. These requirements are:

- State law (Health and Safety Code section 44021(e)) requires ARB, in cooperation with BAR, to compare the emission reductions being achieved to those required by the SIP, assess the emissions impact of continuing the new vehicle exemption, and make recommendations to improve the effectiveness and cost effectiveness of the program. Our report was due to the I/M Review Committee – a legislatively created Committee charged with analyzing the effect of I/M on vehicle emissions and air quality – in January 2000.

- Federal regulation (Code of Federal Regulations, Title 40, section 51.353(c)) requires us to submit a biennial report to the U.S. EPA that quantifies the emission reductions achieved from the Enhanced I/M program, and assesses whether the program is meeting the requirements of the Clean Air Act. The first biennial report was due February 8, 2000, which is two years after the "start date" of the Enhanced I/M program.

Delays in implementing the Enhanced program and collection of the data used to assess its effectiveness have delayed this draft report. We will hold a public workshop and seek public input before finalizing the report. We will also coordinate with the

I/M Review Committee. The I/M Review Committee is also preparing a report to the Legislature on the effectiveness of the program. Information on the Committee's assessment was not available at the time this draft was prepared.

Evaluation Method

In evaluating the effectiveness of the Enhanced I/M program, BAR and ARB used test data from vehicles randomly pulled over at the roadside. We believe this is the best available data from a real world standpoint. Before choosing this method, we considered using data collected by smog check station test instruments, using data collected by remote sensing (a radar-like device that uses an infrared or ultraviolet light beam to instantly measure emissions from vehicles as they drive by), using test data from vehicles pulled over at the roadside, and several methods identified in guidance issued by U.S. EPA.

We chose the roadside pullover method for several reasons. It provides a good random sample of on-road vehicles. We could test the vehicles with the same test equipment used in the licensed smog shops. It also accounts for actual inspections and repairs, pre-inspection and pre-repair (prior to the official Smog Check test), and fraud.

Control Program Effectiveness: Random roadside data collection and analysis. This method was used to assess the effectiveness of the program as it existed in 1999. BAR began collecting roadside data in February 1997. A uniformed California Highway Patrol officer randomly pulled over passenger cars, pick-up trucks and medium-duty vehicles. With the permission of the driver, BAR performed a short inspection of the vehicle. The inspection included an emission test using the same dynamometer and emission measurement equipment used in Smog Check stations. Collection of data began before the Enhanced I/M program was implemented. This provides an historic emission baseline that can be compared to roadside data collected in the future. Roadside data was continuously collected through late 1999. BAR inspected over 27,000 total vehicles, including the subset of 9,400 vehicles that provide the basis for the evaluation in this report.

Enhanced Smog Check testing using dynamometers began in June 1998. In November 1998, NOx inspection standards (or “cut points”) were lowered to approximately gross polluter levels. In October 1999, the cut points for NOx were again made more stringent. We chose to analyze the roadside data collected between November 1998 and October 1999. During this period, the inspection standards were generally constant, and a portion of the fleet had undergone Enhanced testing while the rest had not yet been inspected. This provided a one-time opportunity to make a contemporaneous comparison of the emissions of vehicles that had and had not undergone Enhanced inspection.

The “before” sample includes 5,800 vehicles that had not yet undergone an Enhanced inspection, and the “after” sample includes 4,000 vehicles that had been tested under the Enhanced program (about 400 of these “after“ vehicles also appeared in the “before” sample). Our roadside analysis determines the emission reductions achieved by the Enhanced I/M program during its initial stage of implementation – when the NOx inspection standard was set at a very lax level designed only to identify gross

polluters. We included the tighter NOx cut points implemented in October 1999 when we calculated the effectiveness of the current program.

ARB and BAR staff believe that the "Random Roadside Analysis" is the most accurate methodology for evaluating the exhaust emission reductions of Enhanced I/M. It uses a proven emission measurement method on a random sample of on-road vehicles. It accounts for the effects of Smog Check inspection and repair, pre-inspection and pre-repair (prior to the official Smog Check test), and fraud. The roadside data available in time for this draft report do not account for testing and repair of excess evaporative emissions due to a gas cap check, which we quantify using another method.

Predicted Future Effectiveness: Draft EMFAC2000 Emission Model. The roadside analysis allows us to evaluate the change in exhaust emissions due to Enhanced I/M at just one point in time. We used the draft version of ARB's latest vehicle emissions inventory model – draft EMFAC2000 – to determine the benefits of changes to the program (such as the more stringent inspection standards implemented in October 1999) and to project the effectiveness of the current program in future years. We also used the model to quantify the evaporative emission reductions from gas cap inspections, and the loss of benefits from the exemption of vehicles. We took the model results about program effectiveness and applied them to the emission inventory used in the 1994 SIP to forecast the emission reductions from Enhanced I/M in future years. The draft EMFAC2000 model will be considered for approval by the Board later this Spring, and the effect of any changes that may be made will be incorporated into the final version of this report.

U.S. EPA Methods. In 1998, U.S. EPA published guidance describing Enhanced I/M program evaluation methods. Two of these methods use test data that can be correlated to the U.S. EPA-preferred IM240 test, but cannot be easily correlated to the Acceleration Simulation Mode (ASM) test used in California. U.S. EPA did not approve the use of remote sensing data for these evaluations, pending further study.

A third approved method compares post-inspection emissions and functional inspection results (such as the gas cap check for evaporative emissions) to the emissions data collected in the State of Arizona's Enhanced inspection program. U.S. EPA believes the Arizona program (in which all inspections are performed at centralized, test-only stations using the IM240 dynamometer emission test and advanced testing of evaporative emission control performance) establishes the "benchmark" Enhanced I/M program to which other state programs can be compared.

Although several states have used this method to compare their programs emission reductions to Arizona's, we do not believe that the "benchmark" methodology provides an honest portrayal of the effectiveness of California's Enhanced I/M program. We retained the consulting firm that developed the method for U.S. EPA to advise us on its use in California. The firm determined that the method has not been properly used to date because the data available from Arizona's program does not meet the criteria needed for use in the method. During the 1998-1999 evaluation period for our program, Arizona's program did not meet U.S. EPA specifications. For example, Arizona did not require vehicles to be warmed-up (or "preconditioned") prior to testing, as envisioned

under U.S. EPA specifications. In addition, at that time, Arizona was using interim, less stringent cut points than required by U.S. EPA. In January 2000, Arizona changed its program to require pre-conditioning and improved the inspection standards to meet U.S. EPA requirements.

Because there is not yet sufficient data from Arizona, we have concluded we cannot use the Arizona "benchmark" methodology to evaluate our program at this time. When sufficient data from Arizona become available, it will be possible to use the "benchmark" method to evaluate California's program.

U.S. EPA has encouraged states to propose alternative methodologies as appropriate, and we have done so – basing this report on the random roadside analysis supplemented with the emission model.

Results

The Enhanced I/M program is reducing emissions. We used the roadside data to compare the emissions of thousands of vehicles that had not yet been through Enhanced I/M to those that had. Based on the roadside data, the Enhanced I/M program reduced HC exhaust emissions by 13 percent, reduced NOx emissions by 6 percent, and reduced CO emissions by 12 percent in 1999 (see Chapter III, Table III-3). For NOx, the cut points in effect during roadside testing were at the lax "gross polluter" level, and relatively few vehicles failed due to high NOx emissions. Thus, it is not surprising that the reduction in NOx emissions is less than for the other pollutants. At the end of the roadside testing used in this report, BAR implemented more stringent NOx cut points, resulting in increased NOx reductions.

We used data on the number of vehicles in each model year, their travel frequency, and a correlation equation to convert the roadside test results (a steady state test that measures pollutant concentration) to fleet average emissions in grams per mile. We then calculated the percent reduction in fleet average emissions due to Enhanced I/M by comparing the fleet average emission rate for vehicles before versus after Enhanced I/M. We then used this percent change to calculate the reductions in exhaust emissions in the inventory of the 1994 SIP. We used data from prior studies on the frequency of gas cap failures and the draft EMFAC2000 model to estimate the reductions in HC evaporative emissions from the gas cap check (see Chapter IV). (Although not comparable to the SIP, we also examined the emission reduction benefits of the Enhanced I/M program in Summer 1999 using our most up-to-date inventory assumptions as shown in Appendix A. This is the appropriate figure to use in calculating the cost-effectiveness of the program.)

Emission reductions increase with the newer, more stringent NOx cut points. The roadside data available were collected before the tighter NOx cut points were implemented last October. Since no roadside data are available to show the benefits of the tighter NOx cut points, we used ARB's draft emission model, EMFAC2000, to assess the emission reductions associated with the change in NOx inspection standards. The model is designed to simulate the inspection and repair process of typical I/M programs. The data upon which the model is built comes from testing thousands of cars at ARB's laboratory. The model includes the results of an I/M

pilot program authorized by the Legislature, which was used to design the current Enhanced I/M program. The draft EMFAC2000 model shows that the more stringent NOx cut points implemented in October 1999 increase the NOx reduction from the Enhanced program to 16 percent, compared to the roadside results of 6 percent with the prior cut points.

Emission reductions fall short of expectations. We also used the model to determine how well our current Enhanced I/M program is meeting our SIP commitments for emission reductions. Although the SIP goal was based on more rigorous cut points, annual inspections for gross polluting vehicles, and no vehicle exemptions, these features are not being implemented based on post-1994 legislative changes and concerns about consumer acceptability. In addition, the SIP reductions anticipated an evaporative emissions test equivalent to the U.S. EPA-preferred pressure/purge test. We have implemented a gas cap check to reduce evaporative emissions, but are not achieving all of the anticipated evaporative emission reductions.

Since the SIP was adopted in 1994, we have significantly increased our understanding of vehicle emissions – including substantially higher vehicle emission rates in 1999 than had been projected five years earlier, changes in vehicle population and activity, and two revisions to the emission model used to determine the emission reductions that could be achieved from Enhanced I/M. Although these changes have occurred, the inventory used in the 1994 SIP remains a legally enforceable document upon which we must determine the adequacy of the Enhanced I/M program. On April 10, 2000, U.S. EPA published approval of a revised 1999 SIP for the South Coast Air Basin, which relies on a more recent vehicle emissions model. We will provide the emission impacts for the South Coast using the more recent vehicle emissions model in a separate document.

In addition to the effectiveness of the actual I/M program, our progress toward meeting the 1994 SIP commitment depends upon whether the scope of the current program matches the assumptions modeled in the 1994 SIP to estimate program benefits. In retrospect, the 1994 SIP assumed that additional communities outside the urbanized area, as well as heavy-duty gasoline trucks, would be included in loaded-mode testing. Chapter V provides estimates of emission reductions achieved, in terms consistent with the 1994 SIP, for each affected metropolitan area. Table ES-2 shows percent effectiveness of Enhanced I/M in reducing emissions to meet the SIP target in Summer 1999, based on roadside data.

Table ES-2
Effectiveness of Enhanced I/M in Summer 1999[1]
(based on roadside data)

HC (exhaust + evaporative)	NOx
60%	19%

[1]These percentages are for NOx at gross polluter cut points. BAR increased the stringency of the cut points in October 1999.

However, because BAR increased the stringency of the NOx cut points in October 1999, the roadside data shown in Table ES-2 does not provide an up-to-date portrayal of the SIP benefits of the current Enhanced I/M program. We used the draft EMFAC2000 model to estimate the change in effectiveness if the tighter NOx cut points had been in place for all of 1999. The results are shown in Table ES-3. The modeled effectiveness for HC differs from the roadside results for HC because the draft EMFAC2000 model is based on testing of different vehicles, using different test procedures, than the roadside measurements.

Table ES-3
Effectiveness if Current Enhanced I/M Program
Had Been in Place Throughout 1999[1]
(based on emission model)

HC (exhaust + evaporative)	NOx
68%	51%

[1]These percentages are for NOx at the current cut points implemented in October 1999.

Effect of vehicle exemptions. Newer vehicles, four years and younger, and older, pre-1974 model year vehicles, have been exempted from inspections by statute. About 500,000 older vehicles and 3.8 million newer vehicles are exempt. We used the draft EMFAC2000 model to determine how much emission reductions would increase if these vehicles were subject to inspection. Including older cars in the Enhanced I/M program would increase the effectiveness of the program from 68 percent for hydrocarbon to 75 percent. Because older vehicles have less refined NOx controls, the NOx impact of including these vehicles is much less significant. Requiring newer cars to be inspected at their second birthday would have a negligible impact on program effectiveness because newer vehicles rarely fail Smog Check. Table ES-4 shows the impact of eliminating the older vehicle exemption on program effectiveness.

Table ES-4
Impact of Older Vehicle Exemption on Effectiveness in 1999
(based on emission model)

	HC (exhaust + evaporative)	NOx
Current program (Older vehicles and newer vehicles exempt)	68%	51%
Include 1966-1973 vehicles	75%	53%

Transportation Conformity Impacts of the Shortfall

Established in the Clean Air Act, transportation conformity requires transportation agencies to make affirmative findings that their transportation programs "conform" to the SIP. For motor vehicle-related pollutants (such as HC, CO, and NOx), the SIP also sets a "budget" of emissions from on-road motor vehicles for transportation agencies to show conformity. Motor vehicle emissions with the planned transportation projects in place

must be within the budget in order to receive federal funding. If the new transportation plan or projects would cause emissions to exceed the budget, conformity lapses and new expansion projects cannot be funded. The shortfall in the Smog Check II program creates a more difficult hurdle for transportation agencies to make conformity findings because it results in higher motor vehicle emissions. All Enhanced I/M areas must make new conformity findings this summer.

The transportation agencies need additional data on the effectiveness of California's Basic and Enhanced I/M programs in future years to support conformity assessments. Appendix B provides revised estimates of effectiveness for the Enhanced I/M program for this purpose. (We have concluded that the net effect of the 1997 legislative changes to the program combined with current implementation practices is neutral for air quality in Basic I/M areas.) The Appendix also includes updated control factors for other measures that reduce on-road motor vehicle emissions, and may help remedy the Enhanced I/M shortfall. For the South Coast, we provide new conformity factors in the "currency" of the approved 1999 SIP.

Options For Increasing the Effectiveness of the Smog Check II Program

With the increase in stringency of the NOx inspection standards implemented last October, the emission reductions being achieved by the Enhanced I/M program are significant. Nevertheless, the program is not achieving all of the emission reductions needed to meet the requirements of the SIP, and thus changes to increase the effectiveness are needed.

Based on analysis of the roadside test results and our emissions modeling, several changes to increase the emission reductions from the program appear available. The most significant options that we expect would have direct, quantifiable emission reduction benefits are:

- More stringent inspection standards (cut points);
- Testing of older vehicles; and
- A more comprehensive check for evaporative system and liquid leaks.

More Stringent Inspection Standards. More stringent inspection standards could take several forms. One approach involves tightening the inspection standards for all vehicles, which would result in additional vehicles being repaired. Establishing more stringent cut points, at a point half way between current cut points and the final cut points envisioned in the 1994 SIP would increase the effectiveness of the program in meeting the SIP commitment by about five percentage points for HC and by almost 15 percentage points for NOx.

Another approach involves requiring those vehicles that are failed to be fully repaired – the cut points following repair would be more stringent than the standards used initially to inspect the vehicle. This approach has several advantages. It achieves additional emission reductions from those vehicles already failing Smog Check, thus increasing repair but not inspection costs. In addition, there is some evidence that vehicles that are fully repaired maintain their low emissions for a longer time. This

concept also dovetails well with plans by the State to provide financial assistance for repair.

Testing of Older Vehicles. Older cars continue to contribute a disproportionate amount of emissions, despite their relatively low numbers and use. The current exemption of pre-1974 models becomes a rolling 30-year exemption in 2003 – institutionalizing the loss in emission benefits. One option would be to freeze the exemption for 1973 and older models. As time passes, these older vehicles would remain in the inspection program, however no vehicle currently exempt would have its exemption status changed. Over time, as pre-1974 vehicles represent an ever smaller part of the fleet through retirement, the impact of exempting these vehicles would become negligible.

More Comprehensive Check for Evaporative System and Liquid Leaks. A more comprehensive evaporative system and liquid leak check/inspection could be developed and implemented as a new part of the Smog Check program. To minimize the inconvenience to consumers, this type of inspection could be required for only vehicles past a specific age (based on field studies conducted by BAR). The first steps would be to implement a visual check for liquid leaks and conduct a pilot program to assess the costs and benefits of a more comprehensive effort. We have not yet quantified the likely emission reductions, but believe a comprehensive effort could substantially increase the air quality benefits and move the program closer to the SIP goal.

Other Options. This draft report focuses on the key options we have identified to increase the program benefits, but does not attempt to present a comprehensive analysis of *all* possible program alternatives. For example, one factor that we have not yet evaluated is the relative performance of various station types, i.e., Test-Only versus Test and Repair (or Gold Shield). A very recent BAR report entitled “Smog Check Station Performance Analysis (April 25, 2000)” indicates that vehicles inspected at Test-Only stations produce greater emission reductions than vehicles inspected at Test and Repair facilities. Based on further analysis and comments received from the public, we may add additional options to increase program effectiveness to the final version of this report.

Conclusions

Based on the analyses presented in this report, we conclude the current Enhanced I/M program – Smog Check II – is significantly reducing emissions, although it falls short of achieving the emission reduction commitments in our 1994 SIP for ozone. We also identify changes to the program that would substantially increase emission reductions, and thereby reduce the shortfall.

Timeline For Public Comment and the Final Report.

We are issuing this report in draft form for a 30-day public review and comment period, including a workshop on May 2 in Sacramento. For details contact our website at http://www.arb.ca.gov/html/smog.htm. We are seeking comments on the analysis and results presented in this report, as well as suggestions for changes that will increase the effectiveness of the program. This draft has been submitted to the I/M Review Committee for its consideration, as required by State law. We anticipate finalizing the report and submitting it to the U.S. EPA by June 2000.